

## **Beyond post-modernist criticism versus the scientific method**

We live in a very special time, perhaps a hinge in human history. We could argue that today we are realizing the dreams of the Enlightenment for the first time. The scientific method has produced enough objective knowledge that we are able to develop tools enabling us to tinker with nature, to mimic and substitute nature. While the first industrial revolution used the laws of physics and chemistry to make machines and synthesize products throughout successive waves, we can now break nuclei to release energy, change genes one genetic code letter at a time to create our own by-design hybrids and species which belong outside the repertoire available to nature, use the cellular machinery that expresses genes to read new instructions, use unnatural protein building blocks (amino acids), and create biochemical entities that do not exist in nature.

Just as we have at our discretion these and countless other uniquely powerful tools and techniques, we also face the changes we have made to the planet through our industrial activity and relentless pursuit of one more unit of consumption. Only the underdeveloped world is still in a journey through “the tunnel of necessity”<sup>1</sup>, in which the means and the useful are legitimately valued above the ends and the good<sup>1</sup>, but their impact to the global commons has been minor relative to the aggregate impact of the developed West. We arguably have today enough technology to generate economic growth and surplus while simultaneously reversing the ecological footprint of our industrial societies, if we choose to.

However, we also live unique political and sociological times marked by a general feeling of distrust in science and scholarly expertise in any technical field, and more generally by an anti-establishment feeling. These are times of tribalism, relative truths, and false news. So precisely when technology has brought us to the unfolding of the tragedy of the global commons and given us the unique power we have developed to use, and act on, Nature by our designs and choices, it appears that there are no chances to develop the instruments to do so. The fragmentation of beliefs, ideologies, political wills, makes even a fact-based discussion of the problems unattainable; if all truths are relative, and we must take alternative realities seriously, then how could we even apply methods that require collective actions. These are, therefore, very special times indeed since the will to recognize what really matters does not exist, our technologies can cause more externalities than ever before, and can introduce new unnatural entities to the natural heritage of humankind, the commons.

The western public intellectuals of the late 17<sup>th</sup> and the 18<sup>th</sup> centuries have been replaced by scholar-experts and think-tanks, especially since the end of WWII. The period of stagflation during the 1970s discredited Keynesian state intervention to manage the economy and brought along monetarism, public choice theory, and neoliberalism. The influence of libertarian and neoliberal ideology was, and is, pervasive. For instance, they appear to inform the narrow understanding of common pool resources by ecologist Garret Hardin in his “Tragedy of the Commons” essay<sup>2</sup>, the crafting of the Bayh-Dole patent legislation in the US, a wave of privatizations and deregulation from the UK to the US to countries in the periphery like Argentina, and the creation of technocratic management structures outside the prerogatives of politics e.g. independent central banks as perhaps the happiest realization. There are several reasonable, skeptical arguments to be made about the judgments and recommendations produced by scholar-experts. On one hand, they are generally detached from the immediate impact of policies on the wide public; they also will generally express views aligned with the implicit interests of the establishment that gives them status; on the other hand, experts will naturally have professional biases in the most responsible and genuine assessments they make, we all do. At another level, just as the government has the agency problem identified by Public Choice theory, so do technocratic bodies. Whichever the architecture in place, the cardinal problem is “Quis custodiet ipsos custodes?”, “who supervises the custodians?”, lest special interests end guiding the custodians. In any case, this general structure of government and policy which imposed top-down, often drastic policies and regulations, must reckon today with the complex series of outcomes and the public reaction: alienation from the establishment.

The failures of policies adopted top-down based on scholar-expert assessments and guidelines and carried through by technocratic means is too long to list. It is worth to list a few examples which bring a common shared experience to a lot of people in the world, whom the economic establishment has failed them through mistakes or manipulations. We are still emerging from the financial crisis of 2008, which was created by the financial sector and government regulation crafted for it. Such errors and manipulations have also been made in the domains of medicine and life sciences, for instance the drug thalidomide, the tobacco industry promotion of smoking, the current opioid crisis through over-prescription of pain killers. We can add, for a global overview, the Russian people and the economic recipes by scholar-experts that caused first the collapse of the economy and then the capture of the economy by oligarchs after the dissolution of the USSR; the Washington consensus economic scholar expertise imposed on Argentina towards the end of the 1990s and the concomitant collapse of the foreign debt between 2001 and 2002; the privatization over-drive in many countries, from the UK and Argentina during the 1990s, sometimes with uncontested adverse consequences but privatized monopoly profits; the IMF policies of austerity for peripheral countries with economies in recession but policies of fiscal expansion in the US during the 2008 financial crisis; globalization and the consequences to many local economies practically everywhere in the West, with no precautionary planning and palliatives in place. The common pattern is the custodians giving the regulated interest a protected slice of the financial sector, the economy, human health, as a resource.

The failures discredit technical expertise and validates the view that “truth is made to justify power, whatever this concept may be called: relativism, constructivism, deconstruction, postmodernism, critique. The idea is the same”<sup>3</sup>. It is natural then to understand why post-modern criticism may underpin movements of ideological opposition to GMOs<sup>4</sup>. After all, GMOs are synonym with corporate agricultural industry, and their scientific defense is done by scholar-experts linked in some way to the industry either directly employed, or through funding, or simply due to synergistic research programs. At best, these are the scholar-experts who have achieved affluence and status “accepting society as it is and honoring its values”<sup>4</sup>, not challenging them, and not embedding themselves in the complexity of faraway foreign cultures and practices with different concerns than those tested in the labs. Can we expect a vast public who challenges the power structures of the establishment to take the defense of GMOs at face value? It is about time try to move past current debates and antagonisms between post-modern critics of the scientific method and “classical scientists”, which can only be done recognizing the positions of the two opposite views held on one side by the various anti-science movements and on the other side by the scientific communities. To some degree, the antagonistic discussion appears to be shaped by culture more than objective substance, and it can be a good test case to develop alternative terms of discussion and engagement to be used in the vast range of new technologies we have today. In an article expressing a scientist’s preoccupation with the current disregard for science, Marcel Kuntz<sup>5</sup> develops a defense of the scientific method against “the postmodern school of thought” criticism casting doubt on the validity of “universal scientific truths”. If postmodernism underpins today’s disregard for scientific data in the assessment of our impact to global ecology and climate, the various movements and ideologies driving this attitude are grounded in the broader political realities sketched above; their force derives from inequity, disillusionment, destitution, grievance, and perhaps most of all, of lack of information due to condescendence about ordinary people opinions relative to scholar-experts convictions.

In the essay “The postmodern assault on science”<sup>5</sup>, Kuntz uses GMOs as an example of the scientific method applied to risk assessment, and the destructive battles in a cultural war in which scientific truth is a social construct and all knowledge is relative, no truth universal. In his defense of science as our capacity to objectively understand the natural world and to reach universal truth, his essay focuses on the scientific method. A legitimate argument can be made against established science defense of GMOs safety without doubting the scientific method, indeed arguing that it is not used well enough. The best way to deal with anti-experts and anti-establishment sentiment is to have more independent studies, transparently published, rather than risk assessments mostly

conducted by the GMOs industry<sup>6</sup>. Moreover, the demand for “public engagement”<sup>7</sup> can be given non-nonsense meaning, taking it seriously as a demand for science to address the concerns of an uninformed public. While the co-production of scientific knowledge between laypersons and specialized scientist is a non-sensical claim<sup>7</sup>, the application of the scientific method to questions that concerned communities upon with GMOs will have an impact is very sensible. The laypersons can be engaged not in the technical details of experimental protocols, but in drafting a range of issues to be examined scientifically. It should be the responsibility of the scientific and “technical” or “technocratic” communities to transform the terms of public engagement making it meaningful and useful. The scientific communities are supported by the public in the first place, it is absurd to pretend that they should be detached from the rough working of the polity and the social machinery, with all the friction caused by worn-out or missing gears and broken pieces.

A discussion can quickly degrade into a futile political exercise scarcely above the “name calling” and “fake news” level typical populist politics. The essay by Kunz<sup>5</sup> does not appear to claim that science and scientists are immune to social, political, or market forces as interpreted in the response “‘Regular science’ is inherently political”<sup>8</sup>. Kunz’s essay simply defends to absolute validity of the scientific method as the means to reach objective truth about Nature. A more objective critical approach would indicate that the choice of which problems are chosen for the application of the scientific method are in big part political choices, not that “the science” is. Clearly the application of the scientific method will result in different data and conclusion across different basic aspects of a single problem, but this doesn’t make science itself subjective, political, or relative. The scientific enterprise may be so. The budget for science is allocated according to choices, and in big part these are political. This should make us comfortable and happy. It means, for instance, that across substantially different geographies, climates, ecologies, heritages, economic and sociological realities, a given technology may be judged based on a varied range of merits. Technical and scientific opinions may very well not align themselves when the scientific method is applied to a range of different yet overlapping questions that constitute a complex whole. Why should we be surprised about this? The question “are GMOs safe?” is embedded in a layered context. The answer may be very simple if we are interested only in the direct consumption of a GMO plant, because all other aspects of production are equivalent already, as in the developed world. Or it may be nuanced and composed of trade-offs if the question is concerned with a complex reality that includes changes to established practices and the impact to genetic diversity, and to fragile ecological and socioeconomic systems, as in the underdeveloped world.

The call for “extended peer review and knowledge co-production beyond the classic expert communities”<sup>8</sup> seems very naïve and uninformed; science is indeed very specialized and complex as stated in this debate<sup>7</sup>, and “engaging with end-users of scientific knowledge”<sup>8</sup> is a completely different task. Technology and tools incorporated into society enter a web of linked causes and effects. In the case of GMOs public engagement has meaning not in the specifics of peer review but in the knowledge of the complexity of issues to consider. No doubt public, community engagement, “can substantially benefit scientific design to ask the right questions”<sup>8</sup>, but this is the territory of policy not of science per se. It isn’t that we should not assume that “scientists invariably consider the best interest of society”<sup>8</sup>; rather, we should assume they never do, as they should be driven by their personal curiosity and passion, or perhaps also aspirations of rewards. That the work of scientists is used in the best interests of society is the territory of policy in a healthy polity. Finally, the call for “unpacking” science and “grafting the political wing onto the social architecture of science and its public extensions”<sup>8</sup>, will most likely cause a degradation of science just as we have a degradation of education and economic policy discussions. The goal of realizing “knowledge-based innovations better attuned to societal values and norms”<sup>8</sup> can be greatly leveraged by informed public engagement. In the GMOs case-study of this discussion, it is the responsibility of government regulatory agency to ensure that the concept of “safety” is not defined by the industry only, and that the range of impact points for each GMO is considered in the complexity demanded by each context. It is not the same to consider a specific GMO within a

context of monoculture industrialized agriculture in a western developed country as within a context of small poor farmers in an agricultural context rich in genetic varieties and soil management practices. Whereas the safety of specific GMO products for ingestion is examined through a most rigorous application of the scientific method, the impact of their uses and misuses in under-developed societies, e.g. upon the ecology, distributional economic consequences, the reservoir of traditional practices and genetic diversity, are not examined at all. Scientific results relevant within narrow conditions in developed economies are subsequently used to put pressure on societies that have no mature institutional frameworks to protect their inherently different commons and public goods. Most often the problems are not with each specific GMO plant, but the concomitant change in practices they leverage. These distortions can only be made worse by including more politics into science. It is not in making science political that we will improve but in keeping the scientific method “boxed”, if not “a pedestal”, so it is available to be used for all concerns as politically decided. Perhaps the bottom-line answer is a harder one: it is in improving the health of the political process and public education, not in politicizing science, that we can improve.

There is a fault line that could enable postmodern criticism and traditional science to bridge the gap and come together. It is the question of whether science is or is not intended as something other than what it claims it is doing. We can keep the scientific method separate from what scientists do besides it and consider what is the fabric the scientific enterprise is embedded into. The right question is whether the market and political forces emerging from the privatization and financialization of scientific results are intended as something other than what they claim. The scientific method is not currently being applied to all the relevant aspects, or consequences, of technology and scientific tools with commercial potential. Even within the developed economies which created most of the technologies underpinning today's economy the scientific method is rarely applied to their indirect impact on society and ecology. Instead we are sold the virtues of “disruptive innovation” as if the most important economic goal was to hasten forward technological dreamworlds unhinged from cultural heritage. It is a confusion to think of these problems as the politics of science and technology<sup>8</sup>. To the contrary, these are problems to be decided by politics, acting through policy implementation, and using science as the only means to acquire objective knowledge about each parameter that matters. The answer is not in “unpacking” the scientific method<sup>8</sup>. Certainly, communities of practicing scientists and technologists will be rich in inside politics, will be influenced by politics and markets, and the actions of individual scientists will mostly be as self-serving as those of individuals in any hierarchical architecture. Precisely because of these reasons, the answer lies in embedding science in society through the engagement of an informed public and polity in the decisions about which problems to apply science to, including what range contexts to consider as valid or worthy.

There is no lack of new technologies today, many of which go beyond the potential of GMOs to transform societies and our global commons. The new genetic engineering tools called CRISPRs the best arena to try to change the terms of discussion between the postmodern criticism heirs and the science traditionalists. If we want to ensure the most balanced and ethical development of CRISPR science applications, the answer is not grafting politics to the science and tools. Recognizing the legitimate claims by the skeptics of the objectivity of established scholar-expert communities, and the causes for anti-expert and anti-establishment sentiments is a necessary first step. Indeed, using CRISPR systems as a case study, we can readily verify that the regulatory body approval of new GMOs obtained with these new tools lacks rigorous due diligence. It is based on scholar-experts claims that precise single-letter edits of the genetic code mimic natural selection, unlike the genetic transformation involved in the first generation of GMOs. Yet, large scale undesigned genetic editing has been corroborated by scientific work in a few cases. Thus, the “solemn” and “austere” application of the scientific method for risk assessment, and the boring and slow process of considering a well-studied list of concerns, seems the path forward that can solve the dispute. The engagement of an informed public can leverage our ability to design policy with foresight ex-ante and avoid wasteful subjective battles. Once a deliberate oversight about the properties of a tool or new entity is found to

have hid a harmful effect, like the potential carcinogenic properties of the herbicide glyphosate, the descent into the politics of grievance are unavoidable.

*Letter: a response to “EU verdict on CRISPR crops dismays scientists”<sup>10</sup>*

Gene editing tools branded together as “CRISPR systems” are new and powerful. Because of their relative simplicity, low costs, effectiveness and efficiency, they are already transforming laboratory genetic modification of plants, animals, and insects, ahead of public policy discussions. The underpinning molecular mechanism in microorganisms is a natural wonder and the practical use of the derived laboratory tools is enabling to answer scientific questions with unprecedented range and depth. The tools have revolutionized biological science and there no visible limits to their full potential. They are likely to transform GMOs and create new organisms with heritable traits that nature would have never been able to produce. They can also be used to create organisms such as genetically female cows with male bodies and sterile insects, which would be propagated in the lab for large scale deployment in commercial food production outside the lab. Potentially, these tools could enable us cure cancer, design babies, create laboratory plants and animal designed to our whims or with good sense.

In the US the industry has successfully argued that since the tool introduces precise edits to the genetic code, it mimics natural selection through chance mutations and fitness selection, it should not be subject to regulatory tests for approval. These would remain obligatory for the previous GMO tools based on the transfer of genetic material involving two or more species. Thus, modified plants and animals would not even need to carry the label GMO. Yet scientific work reporting large scale genomic changes caused by CRISPRs tools targeting minimal edits have begun to be published<sup>9</sup>. It is possible that, as usual, a longer time and a critical mass of work will be necessary before truly understanding unsuspected subtleties involved in CRISPRs mechanisms. In Europe, the Court of Justice of the European Union ruled<sup>10</sup> on July 25, 2018, that plants gene-edited with CRISPR systems should be considered at par with “traditional” GMOs, i.e. that the same regulatory framework applies to them.

Why should we not have a nuanced, sophisticated but significantly more ambitious, stance about the wider impact of CRISPR systems in the political and economic context of today? A fictional, exaggerated perspective may help bring the salient points into focus. If an equally cheap, effective, and efficient technical toolkit to produce nuclear fission was invented (the post Bayh-Dole legal framework would lead to a similar manic race for patents, licenses, venture capital involvement and the whole usual bubble created by expectations of monopoly or oligopoly financial returns), the novelty would not simmer slowly in the background. The upside might be captured by technology utopians who would show us the unlimited potential for this “disruptive innovation”, from carbon-free power generation for homes without the need of a power grid, to cars, the transport systems, air travel, navigation, and space travel. However, there will be nowhere to hide from the concerns about radiation risks, nuclear radioactive pollution, national security, and terrorist threats. It is also safe to assume that with respect to measurements of radioactivity and damage cause by different types of ionizing radiation, the validity of the scientific method will not be contested nor considered at par with “other forms of knowledge”. It is in the assessments of risks and evaluation of alternatives that different levels of trust in expert opinion will be expressed. Well, the power of ubiquitous gene editing is no lesser; it may not have the power to blast the entire surface of the Earth as we know it in a few minutes, but has the potential, in combination with other molecular biology tools, to change life as we know it, to cause vast ecological damage, to produce outcomes we have not yet adequately weighted. This is not a wild exaggeration: in private hands it can certainly be used to edit human genomes, making some of the most creative science fiction a valid territory for discussion. And the knowledge about genetic editing derived applying the scientific method is as “hard” as the knowledge about radioactivity. Yet discussions about GMOs produced by CRISPR systems will most likely tend to replicate the irreconcilable differences between scientists advocating GMOS, the industry, and various anti-GMOs political movements.

Past scholarly discussions about GMOs, the scientific method and “postmodern criticism” of science<sup>5-8</sup>, give us the basis from where to build a more useful and productive discussion. CRISPR systems include every issue relevant to the previous generation of GMOs and industrial agriculture, plus a range of unique new challenges. The best strategy to move forward and start a positive, proactive discussion is to start with the effort to find the language and the terms that give legitimacy to the points made across the divide, from “traditional science”<sup>5-8</sup> to “postmodern criticism”<sup>5-8</sup>. While we scientist will defend our curiosity-driven pursuit of objective knowledge about Nature through the scientific method, feelings of grievance and resentment against scholar-experts and “the establishment” are not unhinged fixtures floating in an imaginary sky. The US government decision to place gene-edited plants using CRISPR systems outside GMOs regulations and to go onto the market without labels was based on theoretical arguments, not experiments. Perhaps it was the right decision, but if something eventually goes wrong with just one such plant, the public will feel the mistrust towards establishment scholar-experts justified, and they will be right.

EU scientist working with CRISPR systems or using them, are clearly placed at a disadvantage. EU regulation will result in all the momentum in the field to move outside Europe, to the US and China and other regions. Naturally EU scientists would prefer the EU to give this field or research and technology the same freedom as the US, because they believe in strong science within the EU. However, this is exactly where we are all involved in allowing the headstrong ideological battles to come in, setting the terms of the debate in subjective, judgmental, personalized terms. Those who defend the scientific method from a perceived attacked by relativists may need to demand that the scientific method be applied ex-ante to all relevant aspects of the problem as embedded in society. The problem of course is economic, but this should be confronted and dealt with openly, so that a sensible cutoff in the list of tests derived from a cost-benefit economic analysis would be clear and public. The critics of establishment expertise and scholar-experts’ conflicts of interest through direct links with industry or because of the inherent perceived bias of establishment science, could demand a broader application of the scientific method across societal concerns. Establishing the debate in mutually understandable terms could potentially be more fruitful than asking for politics to be grafted upon science<sup>8</sup> or rejecting the relevance of public involvement in the design of scientific questions. What matters is the application of the scientific method to issues raised by a well-informed, engaged public.

Withdrawing regulatory oversight from new technologies is no different than cutting corporate taxes, the result is the movement to the most favorable economic framework. Just as Silicon Valley high tech moves headquarters to Ireland, the momentum in scientific research moves to the environment with less oversight. A good recent case study is research in stem cells under US restriction passed into law during the Bush presidency: the UK received the upside of the crisis. When it comes to technologies which can result in large externalities, this means that accepting the rules of the game and moving to an environment of lower oversight amounts to participating in the creation of tragedies of the commons. This creates a conundrum with no easy exits; scientists are individuals with the same needs as everybody else, and while recognition may rank higher in their aspirations than in other professions, they depend on the means collectively pursued as a science establishment. However, fighting against reasonable demands for a thorough application of the scientific method to a broad range of public concerns means falsifying the stance in defense of science. Instead of defending the unique role of science as the source of objective knowledge, defending the scientific enterprise as an “end that justifies the means” only perpetuates the grievances of anti-establishment constituencies. The lenses J.M. Keynes<sup>1</sup> applied to capitalism nearly one hundred years ago apply to this conundrum very aptly: “*we must pretend to ourselves and to everyone that fair is foul and foul is fair; for foul is useful and fair is not*”. However, we are no longer going through the “*tunnel of necessity*” that made capitalist “*avarice and usury and precaution*” the necessary gods. The only way to rise above this conundrum is through a consensus stance from a united global scientific community, rather like what is timidly happening with warnings about climate change.

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